

# INTELLIGENT USE OF THE AVN/MRF

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Understanding the performance of an operational model is critical to being able to forecast the sensible weather

- All models have strengths and weaknesses.
- All have trouble handling smaller scale features.
- All have problems with convection.
- All do a decent job in handling the short range (0-36 hr) forecast of synoptic scale features.

# Why models have forecast problems

- Initialization and quality control smooths data fields. Some of the lost detail may be important.
- Lack of data over the oceans and Mexico.
- Atmospheric processes are non-linear; small changes in initial conditions can lead to large forecast variations (this is the basis for ensemble forecasting).
- Model physics are approximations
  - ◆ for lower resolution models, convection is parameterized
  - ◆ for higher resolution models the micro-physical processes are parameterized

The way the physics are approximated can lead to model errors, for example

- The Betts parameterization in the eta is handled differently over land and water
  - ◆ this can cause the eta and meso-eta to erroneously strengthen the coastal front.
  - ◆ and to forecast too much rain along the Gulf and Atlantic Coastal regions

# AVN/MRF APPROXIMATED PHYSICS

- THE AVN/MRF USE A MODIFIED GRELL SCHEME
- THIS USES THE CHANGE IN STABILITY TO DETERMINE WHEN TO RELEASE ENERGY AS CONVECTION.
- NO DIRECT MIXING BETWEEN THE CLOUDY AIR AND ENVIRONMENTAL AIR.  
(except at the cloud top and bottom)
- NO CLOUD WATER EXISTS, THEREFORE ALL WATER IS CONVERTED TO RAIN.

# A NUMBER OF AVN/MRF PERFORMANCE CHARACTERISTICS HAVE CHANGED IN THE PAST YEAR.

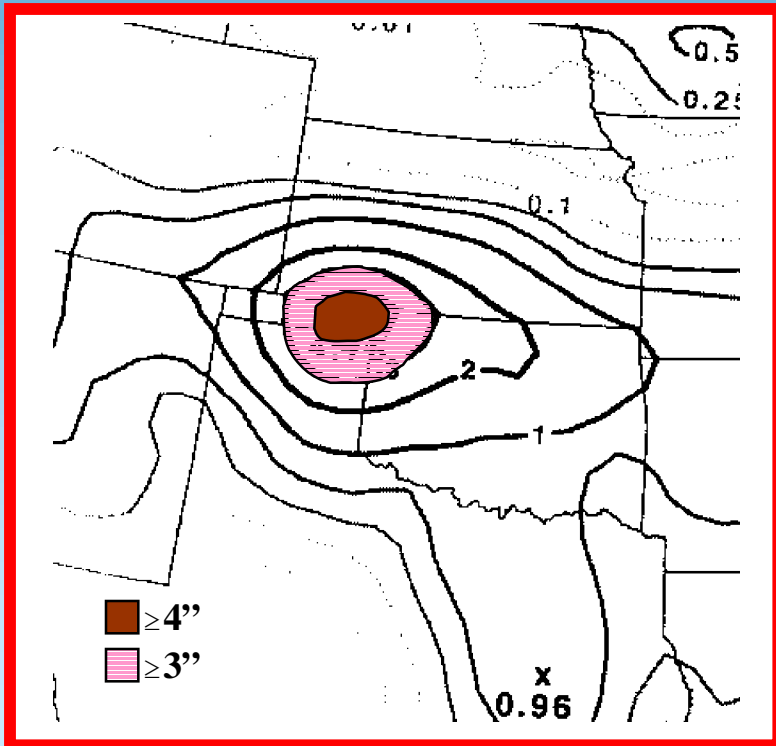
- THE AVN/MRF NO LONGER APPEARS TO UNDERPREDICT PRECIPITATION DURING THE WARM SEASON, ESPECIALLY FOR HIGHER AMOUNTS.
- THE AVN/MRF NO LONGER “OFTEN UNDERPREDICTS SURFACE LOWS, ESPECIALLY OVER OCEANS”
- ISOLATED EXATURATED PRECIPITATION “BULLSEYES” HAVE BEEN A PROBLEM, ESPECIALLY DURING THE WARM SEASON.
- LIKELY DUE TO LESS BAROCLINICITY & SLOW SPEED OF SYSTEMS

# LATEST AVN/MRF CHANGES

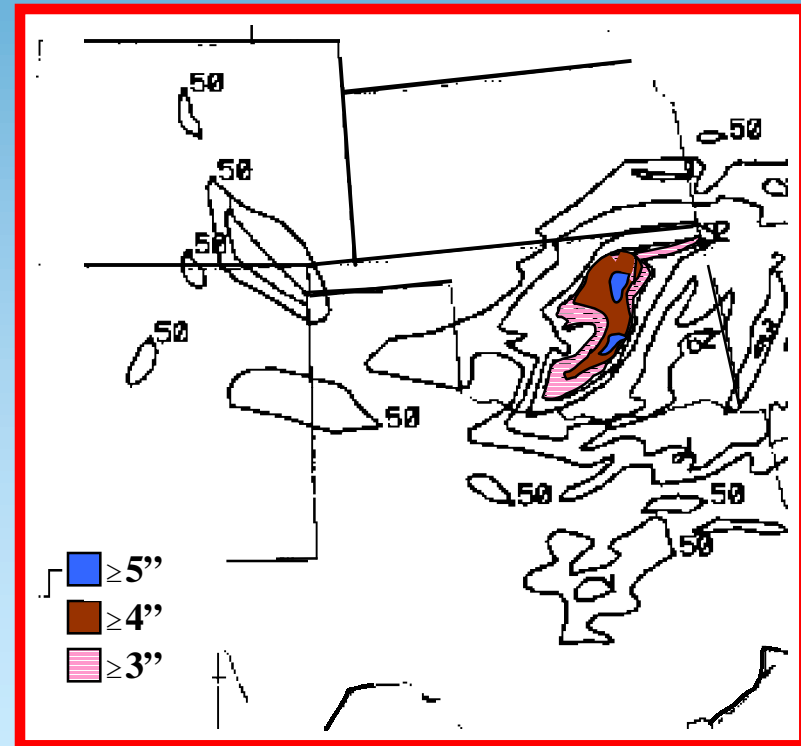
- June 15, 1998: INCREASED HORIZONTAL RESOLUTION TO 170 AND LAYERS TO 42
- THIS LED TO A WARM BIAS AND THE DEVELOPMENT OF SPURIOUS PRECIPITATION BULLSEYES/TROPICAL SYSTEMS
- July 21, 1998: EMERGENCY MODEL IMPLEMENTATION TO REDUCE ERRORS IN THE JUNE 15TH CHANGE

## AVN/MRF Often Have Problems Handling Upslope Events

Around 75% of the precipitation predicted by the AVN during this event was grid scale, rather than convective, precipitation. In these cases, the model QPF is often too far to the northwest. The maximum rainfall falls farther to the south along the surface front.



12-36 hr AVN QPF V.T. 12Z 27 APR 98

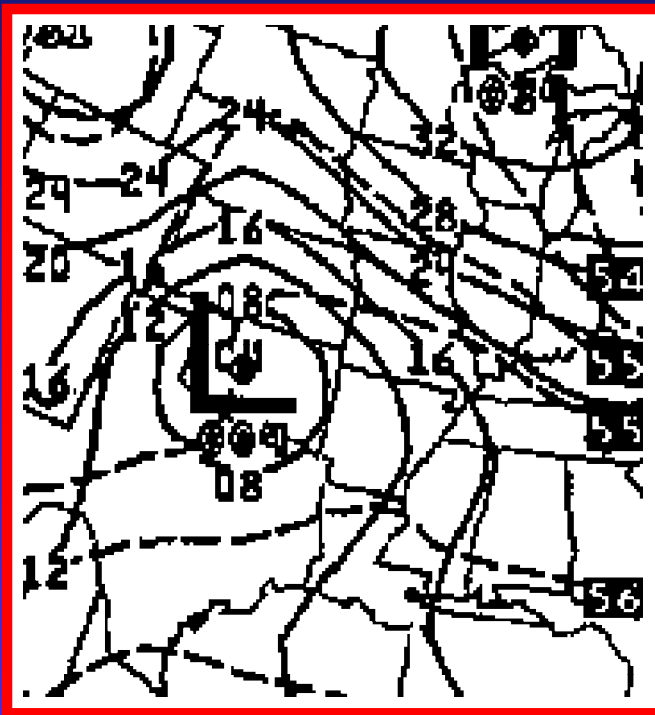


VERIFYING 24H PRECIPITATION  
V.T. 12Z 27 APR 98

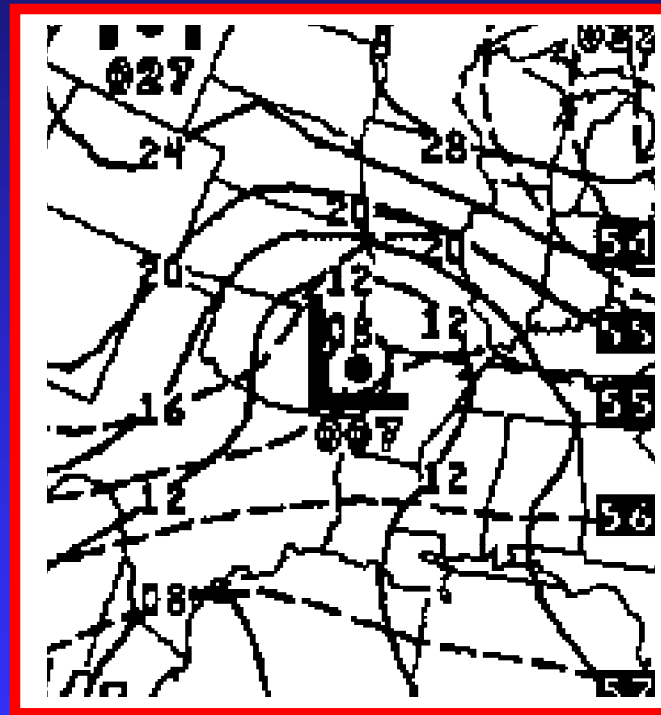


## About 75% of the AVN Rainfall Over the OK Panhandle Was Grid-scale Precipitation (Not Convection).

The overprediction of grid-scale precipitation may result in latent heat being released at too low a level in the atmosphere. This tends to cause pressures to lower, often resulting in the lows wrapping up too far to the west or northwest.



**36-HR AVN/MRF**  
**V.T. 12Z 27 APRIL 98**

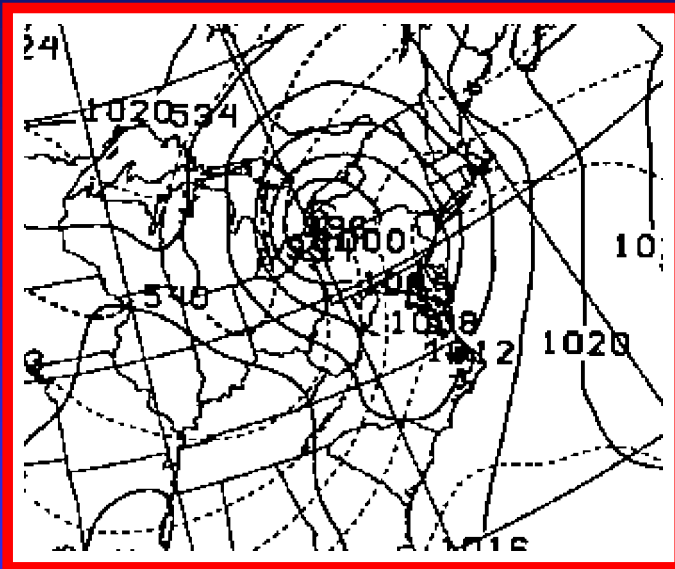


# VERIFYING AVN/MRF

## V.T. 12Z 27 APRIL 98

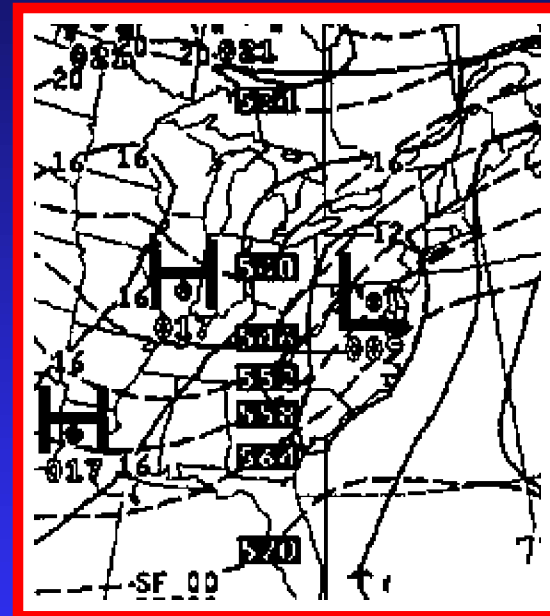
## Another Case: AVN Wraps Low Too Far North And West. Both Surface and 500 mb Lows Are Too Deep.

PRECIPITATION FORECAST IS POOR BECAUSE OF BAD SURFACE AND 500 MB FORECASTS OR VICE-VERSA.



AVN 36 HR FCST

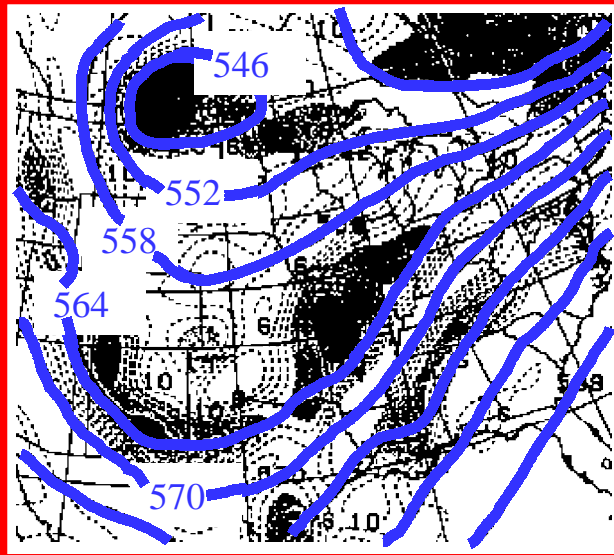
APR 1998



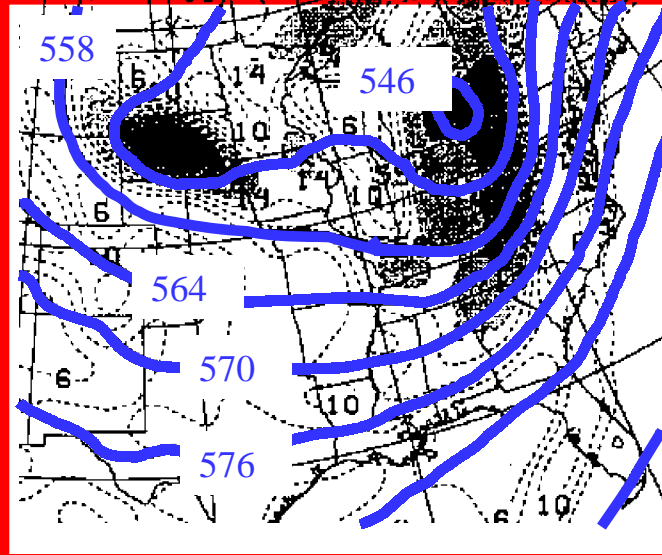
AVN VERIFYING  
SURFACE ANALYSIS  
V.T. 00Z APR 1998

Is this another case with some type of latent heating feedback problem?

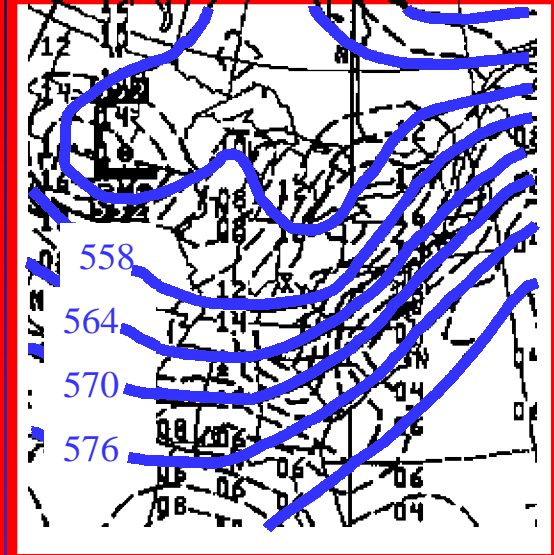
# Aviation Model handling of 500 mb trough



06h V.T. 18Z Apr 18



36h V.T. 00Z Apr 20

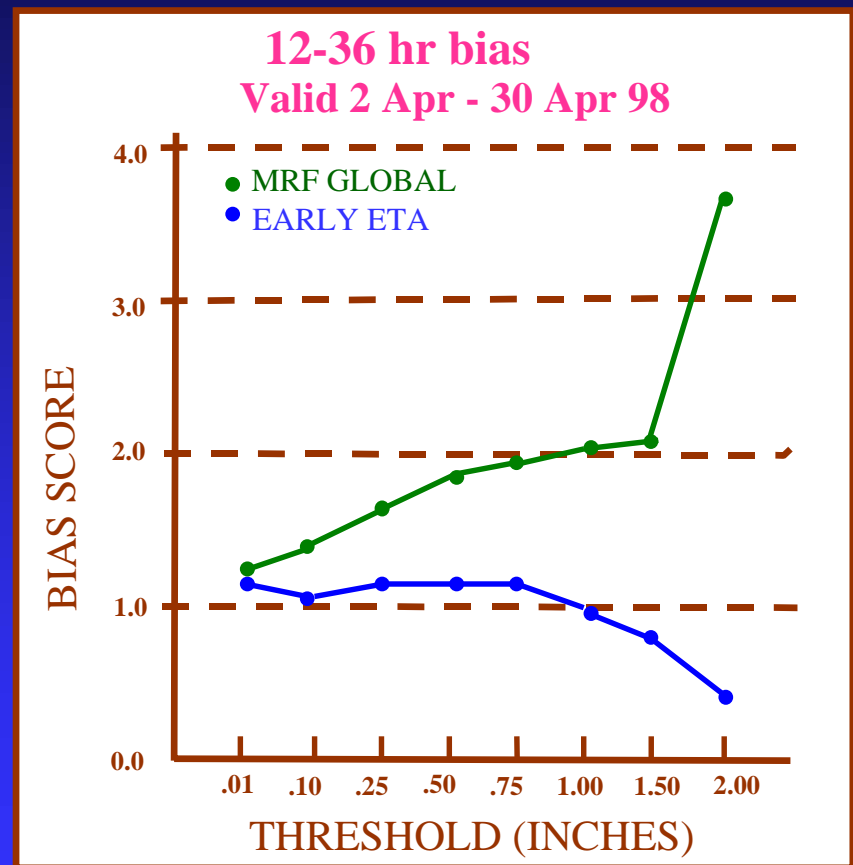
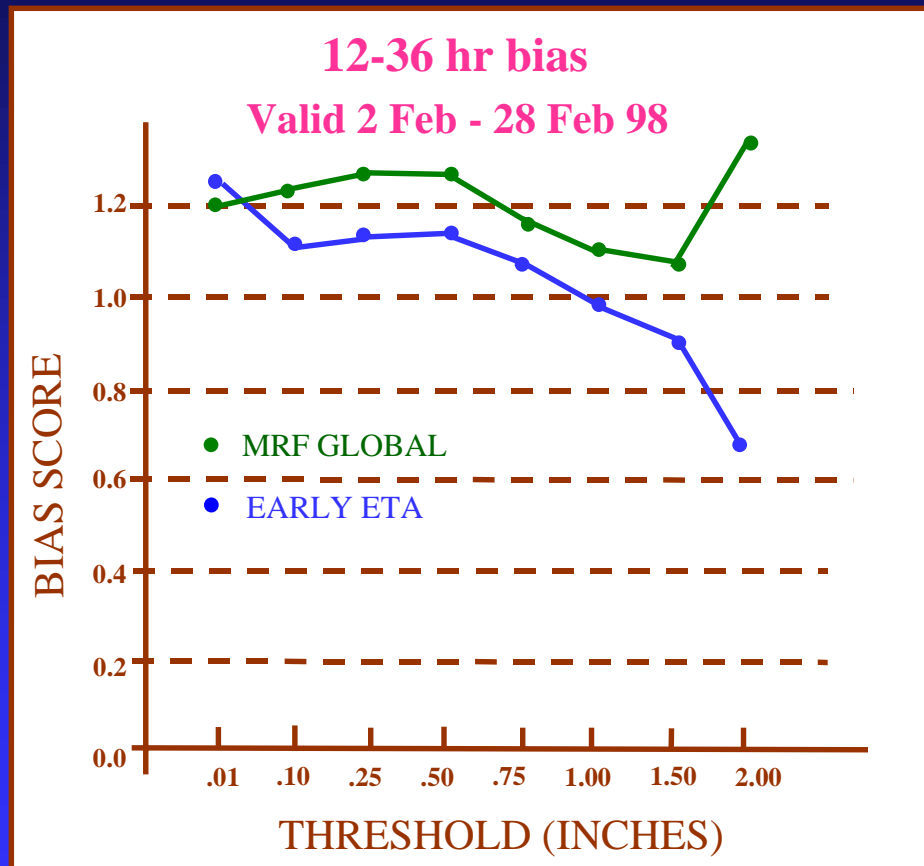


Analysis V.T. 00Z  
Apr 20

The vorticity increases as the system lifts northeastward even though it never taps into or phases with any northern stream energy.

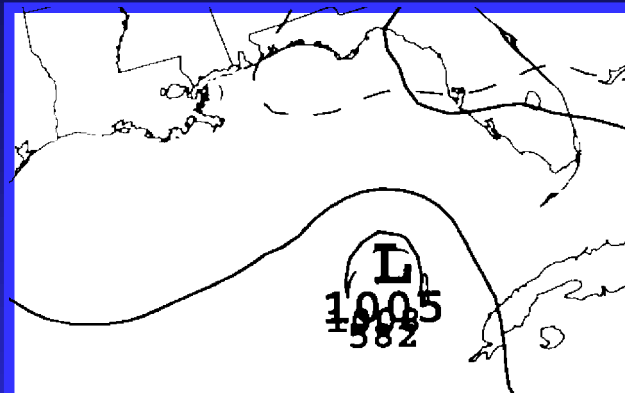
# BIAS COMPARISON OF 12-36 HR MRF AND EARLY ETA FORECASTS

VERIFIED TO AN 80 KM GRID

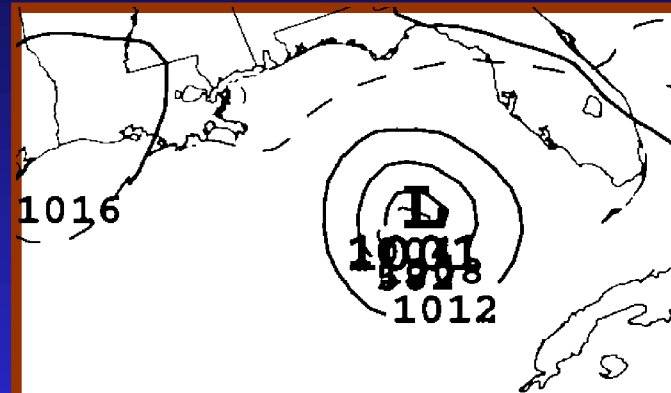


THE MRF AND AVN OVERPREDICT ALL THRESHOLDS ESPECIALLY THE HEAVIER ONES DURING SPRING AND SUMMER

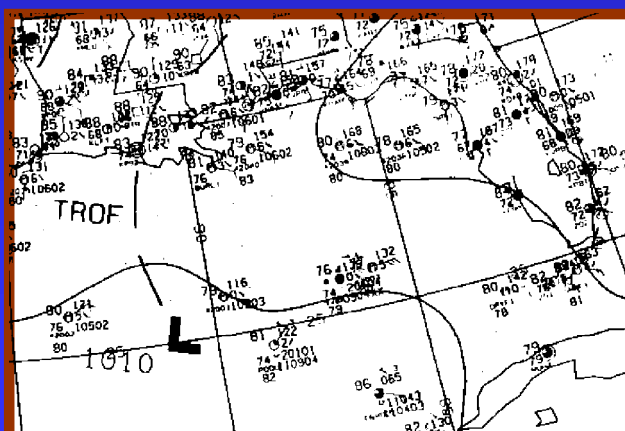
The MRF and MRFX spin-up precipitation bombs and tropical systems erroneously at all time ranges.



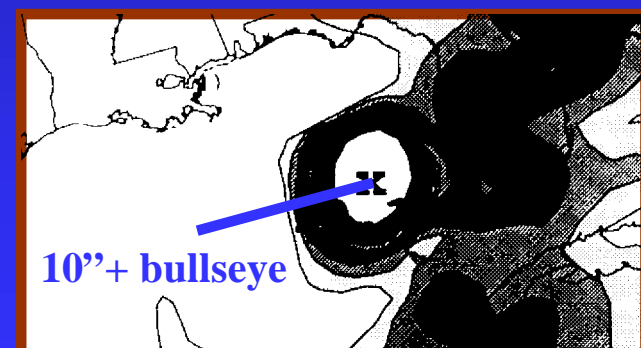
24-h MRFX v.t. 12Z 27 May 1998



36-h MRFX v.t. 00Z 28 May 1998



SFC ANALYSIS v.t. 00Z 28 May 1998

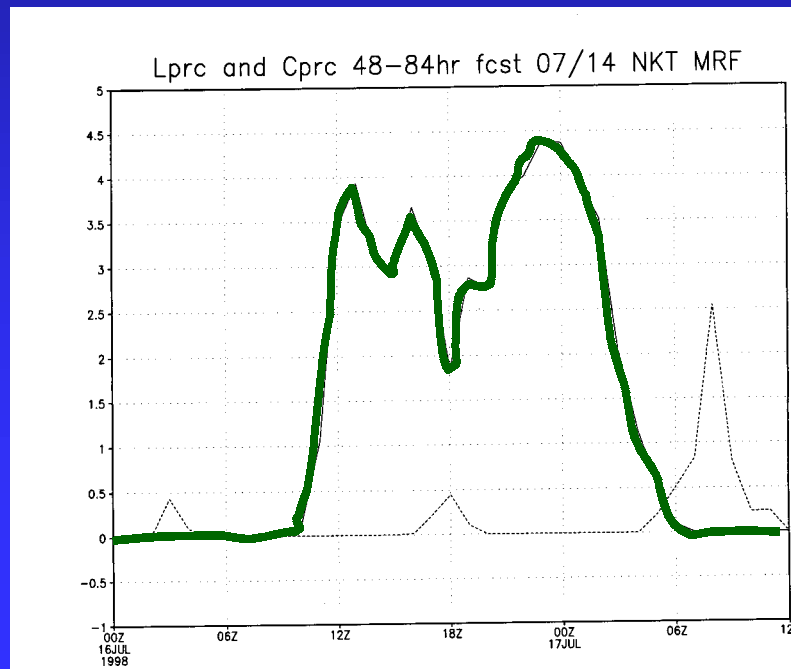


24-36-h MRFX v.t. 00Z 28 May 1998

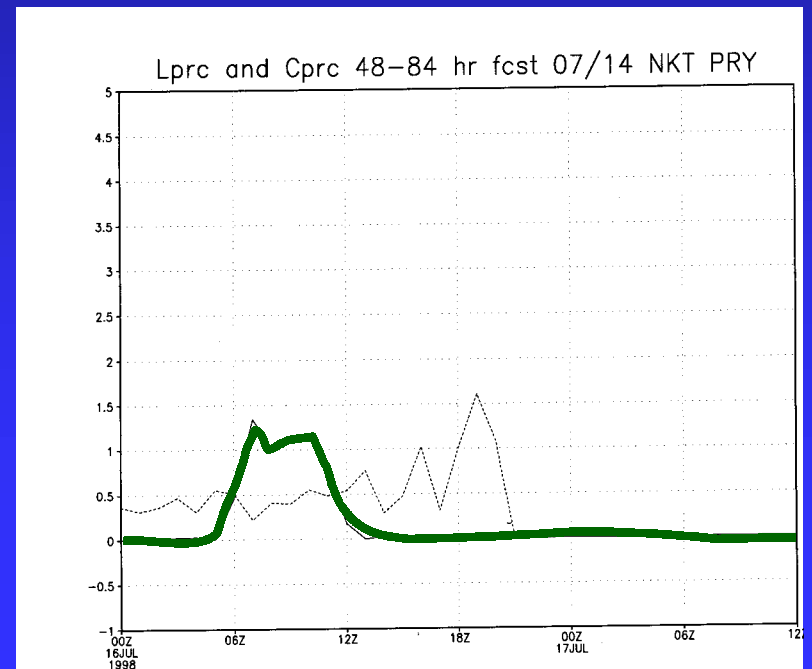
# MRF PRECIPITATION

Convective - dashed  
Gridscale - solid green  
(inches -vs- time)

## BEFORE 7/21

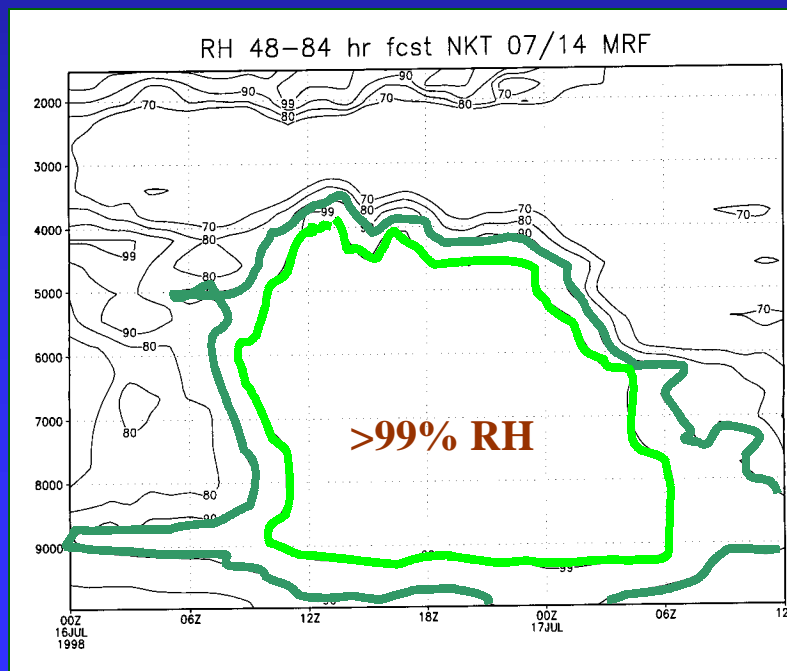


## AFTER 7/21

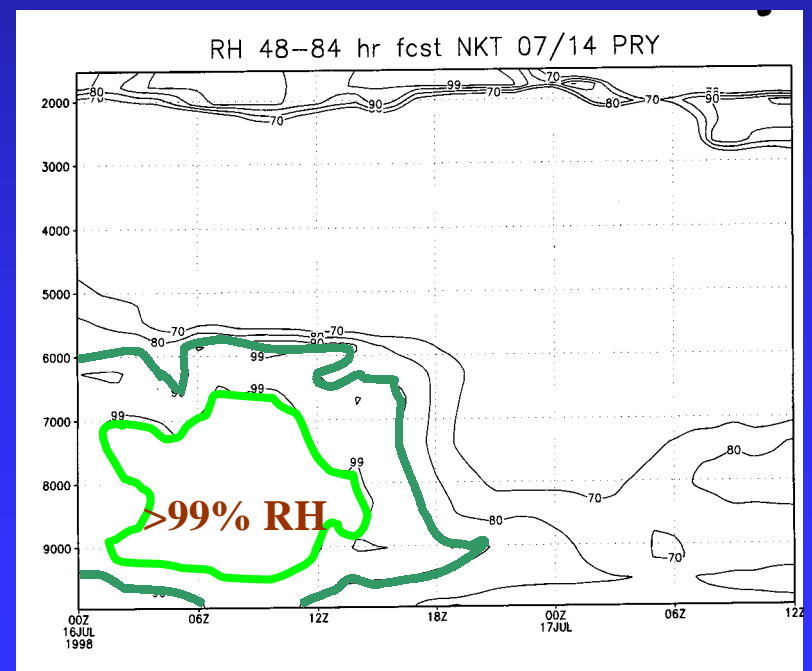


# MRF RELATIVE HUMIDITY (pressure -vs- time)

BEFORE 7/21

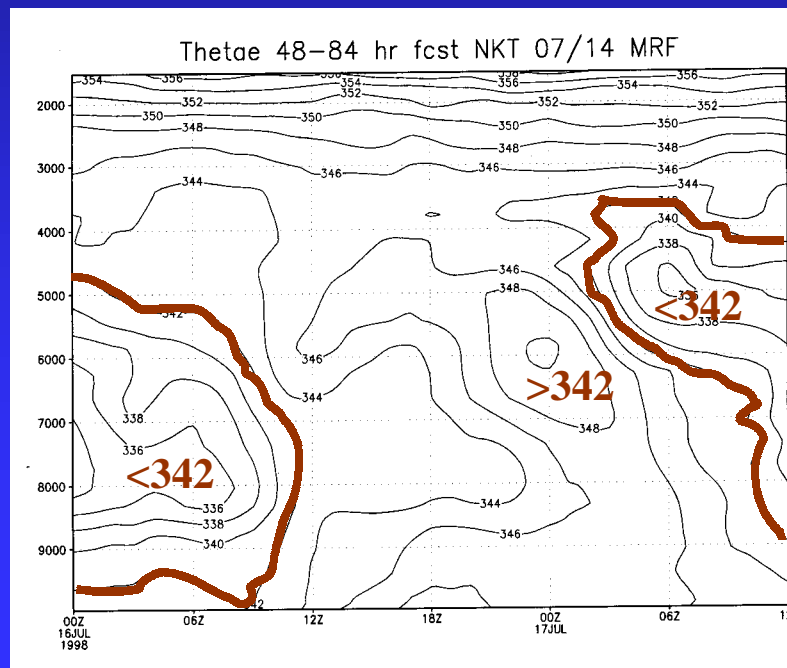


AFTER 7/21

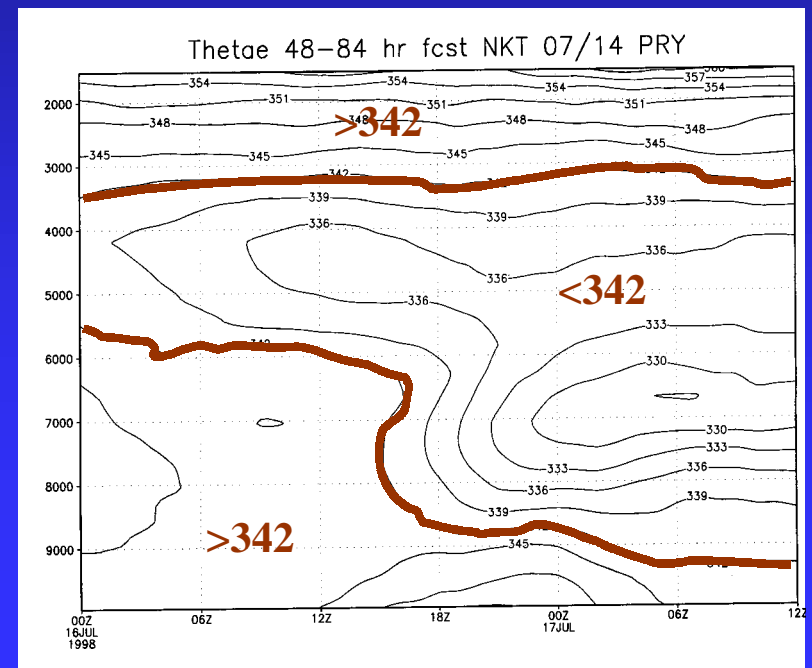


# MRF THETA-E (pressure -vs- time)

BEFORE 7/21



AFTER 7/21





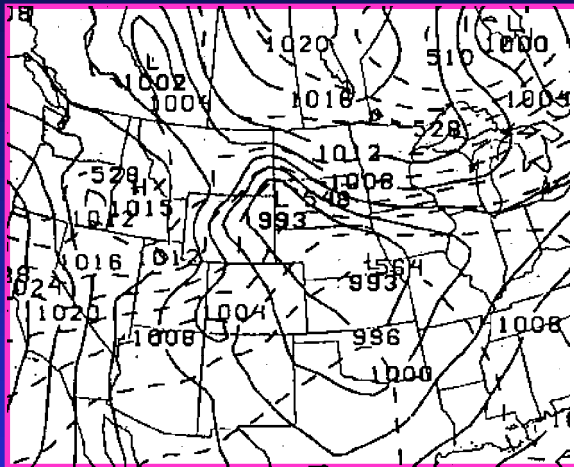
# MRF PERFORMANCE FOR 3-5 DAY FORECASTS

- SHALLOW COLD AIR IS NOT HANDLED WELL. THE MODEL IS SLOW TO TRANSPORT SHALLOW COLD AIRMASSSES, ESPECIALLY ARCTIC AIRMASSSES JUST TO THE EAST OF THE ROCKY MOUNTAINS OR APPALACHIAN CHAIN. THIS IS DUE TO MODEL TERRAIN ERRORS.
- EASTERLY BOUNDARY LAYER WINDS ARE OFTEN OVERPREDICTED ALONG THE FRONT RANGE OF THE ROCKY MOUNTAINS.
- MODEL HAS A SLIGHT COLD BIAS, ESPECIALLY OVER THE EASTERN THIRD OF THE COUNTRY, DURING THE COLD SEASON.

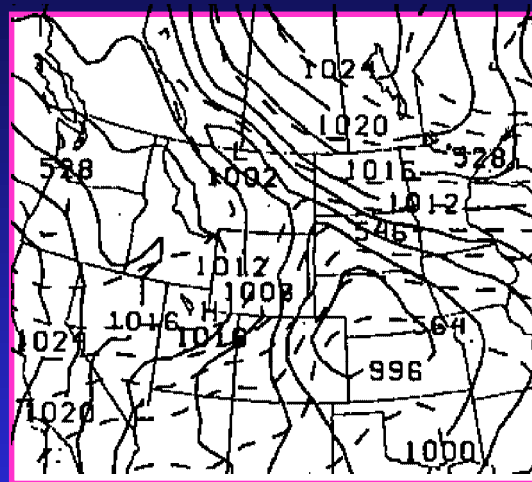
# MRF PERFORMANCE FOR 3-5 DAY FORECASTS (CONT)

- MODEL TENDS TO PHASE SEPARATE STREAMS TOO MUCH. POSSIBLY DUE TO RESOLUTION
- AT HIGH LATITUDES (NORTH OF  $50^{\circ}$ ), THE MODEL PREDICTS TOO MUCH RETROGRESSION
- TENDS TO WEAKEN THE REMAINS OF UPPER LOWS TOO QUICKLY THAT ARE COMING OUT OF THE SOUTHWEST

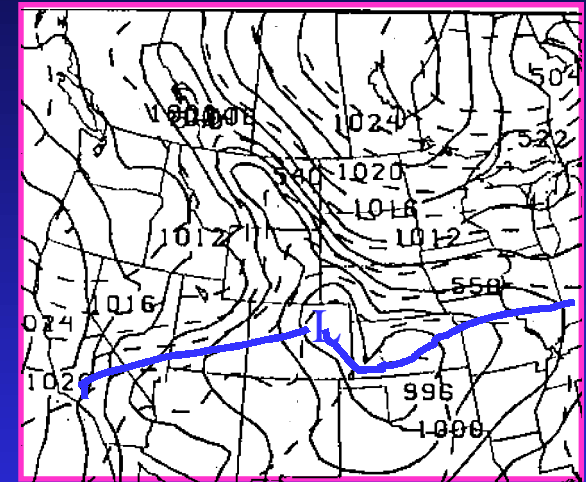
# THE NGM AND AVN/MRF HAVE SERIOUS PROBLEMS WITH ARCTIC AIRMASSES



36 HR NGM V.T. 00Z APR  
09, 1995



36 HR AVN V.T. 00Z APR 09,  
1995



AVN ANALYSIS  
V.T. 00Z APR 09, 1995

TEMPERATURES ACROSS KANSAS WERE IN THE LOW TO MID 50s WITH STRONG NORTH WINDS. SOUTH OF THE FRONT TEMPERATURES WERE IN THE UPPER 70s TO LOW 90s.

# Why models have problems with arctic airmasses

- Terrain is averaged
- Initialization process sometimes robs shallow airmass of its coldness
- Models have problems handling the strength of the inversion
- The leading edge of the ETA LI gradient is often the best indicator of the frontal position

# LOWS TO THE LEE OF THE ROCKIES

- THE AVN AND NGM USUALLY PREDICT THEM TO FORM TOO FAR NORTH
- USE THE 300 MB UPPER LEVEL JET. THE SURFACE LOW IS USUALLY FOUND BENEATH THE LEFT EXIT REGION OF THE JET